

PATENT COOPERATION TREATY

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INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY (Chapter II of the Patent Cooperation Treaty)

(PCT Article 36 and Rule 70)

REC'D 10 MAY 2005

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Applicant's or agent's file reference FP19926	FOR FURTHER ACTION See Form PCT/IPEA/416	
International application No. PCT/AU2004/000822	International filing date (day/month/year) 23 June 2004	Priority date (day/month/year) 26 June 2003
International Patent Classification (IPC) or national classification and IPC Int. Cl. ⁷ C01B 3/24, C10L 3/00, F02M 21/00		
Applicant POWERGEN INTERNATIONAL PTY LTD et al		

1. This report is the international preliminary examination report, established by this International Preliminary Examining Authority under Article 35 and transmitted to the applicant according to Article 36.
2. This REPORT consists of a total of 3 sheets, including this cover sheet.
3. This report is also accompanied by ANNEXES, comprising:
 - a. ☐ (sent to the applicant and to the International Bureau) a total of 8 sheets, as follows:
 - ☐ sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications authorized by this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions).
 - ☐ sheets which supersede earlier sheets, but which this Authority considers contain an amendment that goes beyond the disclosure in the international application as filed, as indicated in item 4 of Box No. I and the Supplemental Box.
 - b. ☐ (sent to the International Bureau only) a total of (indicate type and number of electronic carrier(s)) , containing a sequence listing and/or table related thereto, in computer readable form only, as indicated in the Supplemental Box Relating to Sequence Listing (see Section 802 of the Administrative Instructions).
4. This report contains indications relating to the following items:

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|-------------------------------------|--------------|---|
| <input checked="" type="checkbox"/> | Box No. I | Basis of the report |
| <input type="checkbox"/> | Box No. II | Priority |
| <input type="checkbox"/> | Box No. III | Non-establishment of opinion with regard to novelty, inventive step and industrial applicability |
| <input type="checkbox"/> | Box No. IV | Lack of unity of invention |
| <input checked="" type="checkbox"/> | Box No. V | Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement |
| <input type="checkbox"/> | Box No. VI | Certain documents cited |
| <input type="checkbox"/> | Box No. VII | Certain defects in the international application |
| <input type="checkbox"/> | Box No. VIII | Certain observations on the international application |

Date of submission of the demand 19 April 2005	Date of completion of the report 26 April 2005
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INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY

International application No.
PCT/AU2004/000822

Box No. I Basis of the report

1. With regard to the language, this report is based on the international application in the language in which it was filed, unless otherwise indicated under this item.
 - ☐ This report is based on translations from the original language into the following language which is the language of a translation furnished for the purposes of:
 - ☐ international search (under Rules 12.3 and 23.1 (b))
 - ☐ publication of the international application (under Rule 12.4)
 - ☐ international preliminary examination (under Rules 55.2 and/or 55.3)
2. With regard to the elements of the international application, this report is based on *(replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report)*:
 - ☐ the international application as originally filed/furnished
 - ☒ the description:
 - pages 1-14 as originally filed/furnished
 - pages* received by this Authority on with the letter of
 - pages* received by this Authority on with the letter of
 - ☒ the claims:
 - pages as originally filed/furnished
 - pages* as amended (together with any statement) under Article 19
 - pages* 15-22 received by this Authority on 23.03.05 with the letter of 23.03.05
 - pages* received by this Authority on with the letter of
 - ☒ the drawings:
 - pages 1 as originally filed/furnished
 - pages* received by this Authority on with the letter of
 - pages* received by this Authority on with the letter of
 - ☐ a sequence listing and/or any related table(s) - see Supplemental Box Relating to Sequence Listing.
3. ☐ The amendments have resulted in the cancellation of:
 - ☐ the description, pages
 - ☐ the claims, Nos.
 - ☐ the drawings, sheets/figs
 - ☐ the sequence listing (*specify*):
 - ☐ any table(s) related to the sequence listing (*specify*):
4. ☐ This report has been established as if (some of) the amendments annexed to this report and listed below had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the Supplemental Box (Rule 70.2(c)).
 - ☐ the description, pages
 - ☐ the claims, Nos.
 - ☐ the drawings, sheets/figs
 - ☐ the sequence listing (*specify*):
 - ☐ any table(s) related to the sequence listing (*specify*):

* If item 4 applies, some or all of those sheets may be marked "superseded."

INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY

International application No.

PCT/AU2004/000822

Box No. V Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Claims 1-36	YES
	Claims	NO
Inventive step (IS)	Claims 1-36	YES
	Claims	NO
Industrial applicability (IA)	Claims 1-36	YES
	Claims	NO

2. Citations and explanations (Rule 70.7)

NOVELTY(N)

Claims 1-36

WO 1992/07922

EP 1267432

EP 1354852

Derwent Abstract No. 95-282057/37

None of the above citations disclose a hydrogen gas generator in the form of a reformer to produce a reformat gas containing hydrogen and at least one other material that is produced along with the hydrogen at the same time in the generator including the steps of using the hydrogen generator to produce the hydrogen containing gas blend or mixture, reducing the temperature of the gas blend by passing the gas blend through a heat exchanger to cool the hydrogen gas blend or reformat gas produced by the hydrogen generator prior to introducing the gas blend into the compression engine.

INVENTIVE STEP(IS) :

Claims 1-33 : As above

THE CLAIMS DEFINING THE INVENTION ARE AS FOLLOWS:

1. A method of using a hydrogen containing gas as a fuel, a component of a fuel, a fuel additive or an additive for mixing with a fuel for hydrogen assisted combustion in a compression engine characterised in that the hydrogen containing gas is a gas blend or mixture produced by a hydrogen generator and comprises hydrogen and at least one other material produced in the hydrogen generation process at the same time as the hydrogen is generated including the steps of using the hydrogen generator to produce the hydrogen containing gas blend or mixture, reducing the temperature of the gas blend by passing the gas blend through a heat exchanger, introducing the gas blend or mixture to a compression engine as one component of the fuel and combusting the fuel in the engine, wherein the relative amounts of the hydrogen and of the at least one other material of the gas blend or mixture are selected in accordance with the nature of the at least one other material and the requirements of hydrogen assisted combustion of the engine.
2. A fuel system for a compression engine characterised in that the system comprises a hydrogen containing gas generator for generating a hydrogen gas blend or mixture containing hydrogen and at least one other material at a first temperature, a heat exchanger for reducing the temperature of the hydrogen gas blend or mixture from the first temperature to a second temperature by passing the gas blend or mixture through the heat exchanger prior to introducing the gas blend to the engine wherein the gas blend forms the fuel or one component of the fuel for the engine and wherein the relative amounts of the hydrogen and of the at least one other material of the gas blend or mixture are selected in accordance with the nature of the at least one other material and the

requirements of hydrogen assisted combustion within the engine.

3. A method of operating a hydrogen generation
5 apparatus to produce a hydrogen containing gas, blend or
mixture, suitable for use as a fuel, a fuel component or a
fuel additive characterised in that the hydrogen
containing gas blend or mixture contains hydrogen and at
least one other component that is produced in the process
10 at the same time as the hydrogen is produced by a hydrogen
generator wherein the operating parameters of the hydrogen
generating apparatus are adjusted to provide a preselected
or predetermined composition of the gas blend or mixture
suitable for use in hydrogen assisted combustion of a
15 compression engine in which the respective amounts of the
hydrogen or other component or components are selected in
accordance with the nature of the other component or
components and with the requirements of an engine to which
the gas blend or mixture is introduced in order to
20 facilitate hydrogen assisted combustion of the engine
thereby increasing the efficiency and/or performance of
the engine.

4. A fuel capable of being used for hydrogen
25 assisted combustion of an engine characterised in that one
component of the fuel is a hydrogen containing gas
comprising hydrogen and at least one other material that
is produced by a hydrogen generator along with the
hydrogen during the hydrogen generation process, wherein
30 the relative amounts of the hydrogen and the other
material or materials are selected in accordance with the
nature of the other material or materials and the
requirements of the engine for hydrogen assisted
combustion.

35 5. A hydrogen containing gas blend or mix suitable
for use as a fuel or fuel additive or one component of a

fuel characterised in that the gas blend or mix contains hydrogen and at least one other component in addition to hydrogen in which the other component is produced substantially simultaneously with the hydrogen by a hydrogen generator in which the relative amounts of the hydrogen and the other component is selected in accordance with the nature of the other component and the requirements of the engine for hydrogen assisted combustion within an engine to which the gas blend or mix is introduced.

6. A method of producing at least one component of a fuel for hydrogen assisted combustion of a compression engine in which the fuel includes a hydrogen containing gas characterised in that the hydrogen gas is a gas blend or mixture produced by a hydrogen generator and comprises hydrogen and at least one other material that is produced along with the hydrogen in the hydrogen generation at the same time the hydrogen is generated including the steps of producing the hydrogen containing gas blend or mixture, cooling the gas blend or mixture by passing the gas blend or mixture through a heat exchanger, introducing the cooled gas blend or mixture into the compression engine as at least one component of the fuel wherein the relative amounts of hydrogen and the at least one other material of the gas blend or mixture are selected in accordance with the nature of the at least one other material and the requirements for hydrogen assisted combustion.

7. A gas blend or method according to any preceding claim in which the gas blend or mixture is produced by a hydrogen generator characterised in that the non hydrogen components of the gas produced by the hydrogen generator do not all require full removal prior to combustion of the gas in a compression engine using hydrogen assisted combustion but that the gas blend or mixture containing the other component or components can be used as a fuel or

fuel additive.

8. A method or apparatus according to any preceding claim characterised in that the hydrogen generator is an electrolysis apparatus, a fuel cell, a fuel processor, a reformer, a cold fusion apparatus or other apparatus for producing hydrogen along with one or more other materials.
9. A method or apparatus according to claim 8 characterised in that the fuel cell is a proton exchange fuel cell, a solid oxide fuel cell, an alkaline fuel cell, a direct methanol fuel cell, a molten carbonate fuel cell, a phosphoric acid fuel cell or a regenerative fuel cell.
10. A method or apparatus according to claim 9 or 10 in which the hydrogen generator is a reformer in which steam is used to heat a fuel as it passes over a catalyst provided in the hydrogen generator to produce the hydrogen together with the at least one other material to form the gas blend or mixture in the form of a reformat gas.
11. A method or apparatus according to claim 10 characterised in that the fuel and steam are cracked by passage through the hydrogen generator to form the reformat gas or hydrogen containing gas blend or mixture.
12. A method or apparatus according to claim 10 or 11 characterised in that the reformer reforms a hydrocarbon fuel including petrol, diesel, gasoline or the like to the reformat gas or hydrogen containing gas blend or mixture with the aid of steam.
13. A method or apparatus according to any preceding claim characterised in that the at least one other material is at least one or more of oxygen, nitrogen, water, ethanol, carbon dioxide, carbon monoxide, hydrocarbons, methanol, methane or combinations thereof.

14. A method or apparatus according to claim 13 characterised in that the hydrocarbon material produced in the hydrogen generator is a paraffin or paraffin-like hydrocarbon containing saturated bonds.
15. A method or apparatus according to claim 13 or 14 characterised in that the hydrocarbon is a C_1 - C_{20} hydrocarbon, preferably a C_2 - C_{12} hydrocarbon, more preferably a C_4 - C_{10} hydrocarbon and more preferably a C_8 hydrocarbon, including mixtures of such hydrocarbons and combinations of at least one or more such hydrocarbons.
16. A method or apparatus according to any one of claims 13 to 15 characterised in that the methanol, methane or similar materials produced in combination with the hydrogen gas are produced from a fuel material such as diesel, petrol, canola oil or the like.
17. A method or apparatus according to any preceding claim characterised in that the hydrogen gas blend or mixture produced by the hydrogen generator contains from about 0-50% by volume of hydrogen, preferably 30-40% by volume hydrogen and preferably 35-48% by volume hydrogen.
18. A method or apparatus according to any preceding claim characterised in that the gas blend or mixture includes from about 0-25% by volume of carbon monoxide, preferably 3-5% by volume carbon monoxide, more preferably 4-5% by volume carbon monoxide.
19. A method or apparatus according to any preceding claim characterised in that the gas blend or mixture includes up to about 5% by volume, typically 1-4% by volume, preferably 2-3% by volume of hydrocarbon.
20. A method or apparatus according to any preceding

claim characterised in that the amount of carbon dioxide contained in the gas mix or blend is up to about 25% by volume, preferably 5-15% by volume and more preferably 3-10% by volume.

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21. A method or apparatus according to any preceding claim characterised in that the gas blend or mixture contains the balance of nitrogen.

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22. A method or apparatus according to any preceding claim characterised in that the ratio of individual components in the gas blend or mixture is controlled to be a preselected amount in accordance with the requirement of hydrogen assisted combustion for the particular component.

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23. A method or apparatus according to any preceding claim characterised in that operation of the hydrogen generator is adjusted to produce a desired ratio of hydrogen to the at least one other component in the gas mixture or blend formed by the hydrogen generator.

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24. A method or apparatus according to any preceding claim characterised in that operation of the hydrogen generator is adjusted by altering parameters including one or more of the following, the composition of the materials introduced to the hydrogen generator, the velocities of gases of the various components, the temperature of operation of the hydrogen generator, the pressure of operation of the hydrogen generator, the velocity of gas being passed through the generator, the catalyst being used in the generator, the amount of exposure of the reactor to the catalyst, the type of hydrogen generator used, the nature and composition of the other component produced simultaneously with the hydrogen, the amount of cooling of the gas blend before it is introduced into the engine.

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25. A method or apparatus according to any preceding claim characterised in that the hydrogen generator in the form of a reformer is operated at a temperature of from 100°C-1000°C, preferably from 200°C-900°C, more preferably from 220°C-800°C.

26. A method or apparatus according to any preceding claim characterised in that the hydrogen generator is operated at a pressure of from about 1-5 bar, preferably from about 1-3 bar and more preferably from about 2 bar.

27. A method or apparatus according to any preceding claim characterised in that the catalyst used in the hydrogen generator is nickel, platinum or materials containing nickel or platinum or combinations thereof.

28. A method or apparatus according to any preceding claim characterised in that the gas mixture or blend is added directly to the engine or indirectly to the engine after cooling.

29. A method or apparatus according to any preceding claim characterised in that the gas mixture or blend is added to a mixing chamber prior to being introduced into the engine.

30. A method or apparatus according to any preceding claim characterised in that the compression engine is a diesel engine.

31. A method or apparatus according to any preceding claim characterised in that the system includes one or more heat exchangers to cool the gas blend or mixture or to cool the gas being recycled to the hydrogen generator.

32. A method or apparatus according to any preceding claim characterised in that the gas blend or mixture is

5 added separately to the engine or mixer or in combination with one or more other components of the fuel for the engine, preferably the reformat gas, fuel and any other components required for combustion are introduced to the engine in a single feed line.

10 33. An apparatus or method in accordance with any preceding claim in which the fuel for the compression engine is introduced to the engine separately from the hydrogen containing gas blend or mixture required for hydrogen assisted combustion.

15 34. An apparatus or method in accordance with any preceding claim characterised in that the fuel is diesel fuel, petrol, gasoline or kerosene.

20 35. An apparatus or method in accordance with any preceding claim characterised in that the source of hydrogen and/or the other component produced by the hydrogen generator is a hydrocarbon fuel including diesel, petrol, gasoline or the like.

25 36. A method or apparatus substantially as hereinbefore described with reference to the accompanying drawings.